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Abstract

Electron Beam Welding of Circaloy-2 in the light of the destructive construction-material test.

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In an endeavour to find a suitable welding method for construction elements of Zircaloy-2 subjected to mechanical stress, the welding methods -

- Electron-beam welding
- Flash butt welding
- Argonarc welding

were investigated as to the following criteria:-

1. Static tensile test at 20°C. and 300°C
2. Bending test
3. Fatigue test
4. Creep test
5. Metallographical tests.

So as to lose as little static strength as possible in a cold formed basic material through the welding process, the welding zone must be confined and must be cooled as rapidly as possible from high temperature, to favour the Martens transition $\beta \rightarrow \alpha$. These requirements all call for the electron-beam welding with high accelerating stress.
The loss in tensile strength over the weld seam on ~ 20% cold formed material is approx. 10% at room temperature

employing the electron-beam welding, and about 30% with argonarc welding.

The fracture with the static tensile test in respect of all welding methods is in the welding zone and with the creep test, employing the electron-beam welding, it is always in the basic material (with the other welding processes at high loads it is generally in the weld), which infers that the welding in an element submitted to creeping represents no weak point.

With the bending test the flash butt welding shows exceptionally good results, since in the welding zone there is, per se, very little transition structure that has less ductility than cold formed re-chrystalised Zircaloy-2.

During the fatigue test with every kind of weld the fracture appears in the heat affected structure. At room temperature the fatigue strength is reduced by approx. 12% with the electron-beam welding method at tensile pulsating load, while the percentage is higher with the other welding procedures.

The results from the destructive tests - as well as the excellent reproducibility of flawless weldings with the electron beam shown by the non-destructive testing methods (ultrasonic and X-ray) - reveal that the application of this procedure for construction elements of Zircaloy-2 submitted to mechanical stress is to be recommended.

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Abstract

Extraction Studies on Selected Problems in Reprocessing*)

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The paper discusses various topics in the field of reprocessing which have received particular attention in a chemistry project connected with the operation of the Kjeller Reprocessing Facility.

One of the methods extensively used by us is extraction chromatography. The method which combines advantages of multiple extraction and operational ease of column chromatography, performs sharp separations based on relatively small differences in extractability. The columnsused contained a film of tributyl phosphate (TBP) on an inert, hydrophobic support material. The method was used for sharp, analytical separations and for convenient performance of normal extraction operations on laboratory scale.

A particular application was the isolation and separate determination of trivalent, quadrivalent, and hexavalent plutonium. Pure unstabilized solutions of these species in nitric acid were prepared and studied. A similar technique was used for analytical control of plutonium valencies in reprocessing plant feed solution.

Isolation of various extractable nitrosyl ruthenium nitrato complexes was also performed by extraction chromatography. Solutions of these compounds yielded sharp elution bands, indicating five different complex fractions. Elution behaviour of the TBP-extractable species using various acids was studied. Samples of the extractable species could be obtained free of nitric acid. Correlation of this method with paper chromatographic separations, using normal and ion exchange papers are discussed. The use of extraction chromatography in determining the amount of highly extractable ruthenium in Purex feed

*) Work carried out at Kjeller, Norway, as a joint project of the Norwegian Institutt for Atomenergi and Reactor Centrum Nederland

solutions is described.

Based on results concerning the behaviour of various elements in chromatographic extraction columns a chromatographic one-cycle "Purex-type" procedure was designed. A sample of a reprocessing feed solution was applied on top of a TBP-column. Fission products were removed by eluting with two different concentrations of nitric acid. Plutonium was eluted under reducing conditions and uranium removed by slightly acidified water. This quick and easy separation procedure gave almost quantitative yield of plutonium and uranium and the separation factor from fission products was in the order of 10^4.

Methods for the analysis of the TBP-phase in reprocessing included separation of plutonium and uranium by selective stripping from a TBP-TTA solution. The influence of synergistic effects on optimal conditions for separation was studied.

The following part of the work is related to the use of amine extractants for purification of "Purex" plutonium product. Tertiary amines have been found very satisfactory extractants. Certain quaternary ammonium nitrates were found even more effective in extracting plutonium. A number of quaternary compounds were tested as extractants. Structural effects were found.

When small amounts of certain quaternary compounds were blended in a tertiary amine solution, a considerable enhancement in extraction of plutonium (IV) occurs. The formation of a mixed complex is indicated and synergism occurs. The possibility of using this effect in practical extraction systems will be discussed.